UNITED STATES PATENT AND TRADEMARK OFFICE

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

Ex parte MICHAEL MATTHEW M. CROUSE,
YOURI JOHANNES LAURENTIUS MARIA VAN
DOMMELEN, PENG LIU, HUA-YU LIU, AIQIN JIANG, and
WENJIN HUANG

Appeal 2016-002947
Application 13/753,401[1]
Technology Center 2800

Before GEORGE C. BEST, BRIAN D. RANGE, and LILAN REN,
Administrative Patent Judges.

RANGE, *Administrative Patent Judge.*

DECISION ON APPEAL

SUMMARY

Appellants appeal under 35 U.S.C. § 134(a) from the Examiner's
decision rejecting claims 1–20. We have jurisdiction. 35 U.S.C. § 6(b).

We AFFIRM-IN-PART.

STATEMENT OF THE CASE[2]

Appellants describe the invention as relating to reconfiguring a lithographic system (for use in, for example, manufacturing an integrated circuit) by optimizing a cost function. Spec. ¶¶ 3. 18. Claim 1, reproduced below with emphasis added to certain key recitations, is the only independent claim on appeal and is illustrative of the claimed subject matter:

> 1. A computer-implemented method for improving a lithographic process for imaging a portion of a design layout onto a substrate using a lithographic projection apparatus comprising an illumination source and projection optics, the method comprising:
>
> computing a multi-variable cost function of a plurality of design variables that are characteristics of the lithographic process, at least some of the design variables being characteristics of the illumination source and the design layout, **the computing of the multi-variable cost function accounting for an effect on optical characteristics of the projection optics induced by imaging the portion of the design layout with the illumination source through the projection optics**; and
>
> reconfiguring the characteristics of the lithographic process by adjusting the design variables until a defined termination condition is satisfied.

Appeal Br. 22 (Claims App'x).

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[2] In this decision, we refer to the Final Office Action mailed September 4, 2014 ("Final Act."), the Appeal Brief filed June 2, 2015 ("Appeal Br."), the Examiner's Answer mailed November 19, 2015 ("Ans."), and the Reply Brief filed January 14, 2016 ("Reply Br."). References to the Specification are made to the June 17, 2014, substitute Specification ("Spec.").

REFERENCE AND REJECTION

On appeal, the Examiner maintains the rejection of claims 1–20 under 35 U.S.C. § 102(e) as unpatentable over Feng et al., U.S. Patent No. 8,560,978 B2, issued October 15, 2013 (hereinafter Feng). Final Act. 2; Ans. 4. The Examiner has withdrawn the prior rejection under 35 U.S.C. § 112. Ans. 4.

ANALYSIS

We review the appealed rejections for error based upon the issues identified by Appellants and in light of the arguments and evidence produced thereon. *Cf. Ex parte Frye*, 94 USPQ2d 1072, 1075 (BPAI 2010) (precedential) (cited with approval in *In re Jung*, 637 F.3d 1356, 1365 (Fed. Cir. 2011) ("it has long been the Board's practice to require an applicant to identify the alleged error in the examiner's rejections")). After considering the evidence presented in this Appeal and each of Appellants' contentions, we are not persuaded that Appellants identify reversible error except as explained below. Thus, we affirm the Examiner's rejection except for the rejection of claims 3–6 and 9 for the reasons expressed in the Final Office Action and the Answer. We add the following primarily for emphasis.

Claims 1, 7, 10, 11, 13, 14, 16–20. Appellants do not separately argue claims 7, 10, 11, 13, 14, or 16–20. Appeal Br. 20. We therefore focus on claim 1, and claims 7, 10, 11, 13, 14, or 16–20 stand or fall with that claim. 37 C.F.R. § 41.37(c)(1)(iv) (2013).

The Examiner finds that Feng teaches computing a multi-variable cost function using a plurality of design variables that are characteristics of the lithographic process where at least some of the design variables are

characteristics of the illumination source and design layout. Final Act. 2–3 (providing citations to Feng). The Examiner finds that the computation accounts for an effect on optical characteristics of the projection optics induced by imaging the portion of the design layout with the illumination source through the projection optics. *Id.* at 3; *see also* Ans. 4–6; Feng 11:24–12:5. The Examiner further finds that Feng teaches reconfiguring the characteristics of the lithographic process by adjusting design variables until a defined termination condition is satisfied. *Id.*; *see also* Ans. 8 (citing Feng Fig. 5). The Examiner thus concludes that Feng anticipates claim 1. Final Act. 2. A preponderance of the evidence supports the Examiner's findings and conclusion.

Appellants argue that the Examiner's citations do not teach "computing of the multi-variable cost function accounting for an effect on optical characteristics of the projection optics induced by imaging the portion of the design layout with the illumination source through the projection optics. . . ." Appeal Br. 8–12; Reply Br. 2–5. In particular, Appellants argue that the Examiner "is confused" about the difference between computing cost function based upon "an effect on optical characteristics of the projection optics" (as recited by claim 1) as opposed to computing the function based upon "an effect of the projection optics" (not recited). Reply Br. 3.

To better understand Appellants' position, we first assess the meaning of the "computing . . ." recitation at issue. The recitation requires computing a cost function (i.e., a representation of "a figure of merit of the system"). Spec. ¶ 48. Cost in this context is not necessarily financial cost; rather the cost function can be a function of technical evaluation points. *Id.* This

computation of the cost function must account for the recited "effect." Appeal Br. 22 (Claims App'x). The effect is the effect on the optical characteristics (for example, light intensity distribution and/or phase distribution, Spec. ¶ 50) of the projection optics (defined as "any optical component that may alter the wavefront of the radiation beam," *id.* at ¶ 49[3]) induced by imaging through the projection optics. Thus, claim 1 differs from, for example, computing cost based only on the dimensions of the projection optics prior to illumination.

We assess the Examiner's position with this scope of claim 1 in mind. The Examiner finds that the cost function of Feng is computed based on various design variables. Ans. 5; Feng 11:24–38. Feng teaches that, preferably, the design variables include "adjustable characteristics of the projection optics." Feng 11:55–56; *see also* Ans. 5. Feng further teaches that the projection optics' characteristics may change due to, for example, temperature variation and/or thermal expansion. Feng 11:64–12:5; *see also* Feng 4:16–23 (teaching that design variables means parameters of the projection apparatus including characteristics of the projection optics). Feng further explains that "[s]uch changes can be simulated from a model or actually measured." Feng 12:4–5.

Feng explicitly teaches operation of a laser as part of the projection apparatus's imaging process (*see, e.g.,* Feng 8:40–49), and, as suggested by Feng, some degree of heating is a natural result flowing from the imaging/use of the laser (*see, e.g., id.* at 11:64–12:5). *Cf. Schering Corp. v.*

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[3] Claim 1 requires accounting for an effect based on imaging "through the projection optics." Thus, the context of claim 1 further limits the "projection optics" to optical components that the illumination may pass "through" to at least some degree.

Geneva Pharms., Inc., 339 F.3d 1373, 1379 (Fed. Cir. 2003) ("[a] limitation or the entire invention is inherent and in the public domain if it is the natural result flowing from the explicit disclosure of the prior art") (internal quotes and citation omitted). Feng also teaches that its projection apparatus is subject to temperature variations over time. Feng 6:41–46 (referring to optimization due to behavior deviation of the projection apparatus over time due to temperature), 11:64–12:5 (referring to using projection optics to correct for distortions caused by temperature variation in the projection apparatus and thermal expansion of components of the projection apparatus). A person of skill in the art reading the Feng reference as a whole would understand that imaging (i.e., operation of the imaging laser) would heat the projection apparatus, including the projection optics.

Thus, a preponderance of the evidence supports Feng teaching that its cost function may account for changing characteristics of the projection optics where the changes are caused by heat induced by the imaging process. Final Act. 2–3; Ans. 5–6. Appellants' argument, therefore, does not identify reversible error in the Examiner's rejection of claim 1. We thus sustain the Examiner's rejection of claims 1, 7, 10, 11, 13, 14, or 16–20.

<u>Claim 2</u>. Claim 2 recites "[t]he method of claim 1, wherein the effect comprises a heating effect." Appeal Br. 22 (Claims App'x). As explained above, Feng teaches that the design variables include "adjustable characteristics of the projection optics" and further teaches that these characteristics may change due to heat. Appellants argue that Feng is only describing "that the projection optics can be used to correct or compensate for distortions caused by temperature variation or thermal expansion" but does not teach that the temperature variation or thermal expansion is on the

projection optics. Appeal Br. 13. We disagree for the reasons stated by the Examiner and as explained above. Ans. 7. Feng teaches heat effects within the projection apparatus (Feng 11:64–12:5), and the projection apparatus includes the projection optics (*id.* at Feng 4:16–23; 8:40–53; Fig. 1). *See also* Feng 13:52–63 (referring to "aberrations introduced by the projection optics").

Appellants' argument that Feng does not teach that imaging causes the heat and thermal expansion (Appeal Br. 13) is addressed above in conjunction with our analysis of claim 1. Because a preponderance of the evidence therefore supports the Examiner's rejection of claim 2 and because Appellants' arguments do not identify reversible error, we sustain this rejection.

Claims 3 and 5. Claim 3 recites "[t]he method of claim 1, further comprising determining the effect using at least some of the design variables that are characteristics of the design layout and the illumination source." Appeal Br. 22 (Claims App'x). Claim 5 recites "[t]he method of claim 1, wherein the reconfiguring comprises redetermining the effect using at least some of the design variables that are characteristics of the design layout and/or the illumination source and that are adjusted." *Id.* at 23.

The Examiner finds that "projection optics" are among the design variables in the cost optimization and that, as explained above, the effect on optics is part of the cost function. Ans. 7 (providing citations to Feng). The Examiner also finds that Feng's cost function involves optimization of design variables (including design layout and source). *Id.* at 8; *see also* Feng. Fig. 5. Appellants argue that Feng does not teach, however, that determining the effect on optical characteristics caused by imaging using

characteristics of the design layout and the illumination source (claim 3) and argue that argue that even if the design variables are adjusted this does not mean that the effect must be recalculated (claim 5). Appeal Br. 13–15; Reply Br. 5–6.

Although a preponderance of the evidence supports that Feng teaches the recited effect can be simulated from a model (Feng 12:2–5) and teaches that adjustable characteristics of the projection optics are a design variable for the cost function that can change based on, for example, temperature (*id.* at 11:55–56, 11:64–12), the Examiner does not explain where Feng teaches that characteristics of the design layout and the illumination source would be used to determine the recited effect. Rather, the portions of Feng cited by the Examiner (*see, e.g.,* Ans. 7 (citing 4:6–25)) merely explain that the source and mask can be design variables in the cost function (as opposed to variables used to calculate the recited effect). Accordingly, we do not sustain the Examiner's rejection of claims 3 and 5.

Claims 4 and 6. Claim 4 recites "[t]he method of claim 1, wherein computing the multi-variable cost function comprises using a projection optics model that is a function of the effect." Appeal Br. 22 (Claims App'x). Claim 6 recites "[t]he method of claim 1, wherein the reconfiguring comprises computing the multi-variable cost function using a projection optics model that is a function of the effect." *Id.* at 23. The Specification defines a projection optics model by stating that it "represents optical characteristics (including changes to the light intensity distribution and/or the phase distribution caused by the projection optics) of the projection optics." Spec. ¶ 50; *see also* Feng 9:33–40.

Feng teaches that the projection optics model can represent characteristics of the projection optics "that include aberration, distortion, refractive indexes, physical sizes, physical dimensions, etc." Feng 9:57–61. As explained above, the evidence also supports the Examiner's finding that "the effect on projection optics are accounted for when determining the cost function." Ans. 8. The Examiner, however, does not cite evidence establishing that Feng teaches that the recited effect is used as an input variable to a projection optics model (i.e., "a projection optics model that is a function of the effect"). Appeal Br. 15–16; Reply Br. 6–8. We, therefore, do not sustain the Examiner's rejection of claims 4 or 6.

Claim 8. Claim 8 depends from claim 7. Claim 7 recites "[t]he method of claim 1, wherein the design variables comprise an adjustable optical characteristic of the projection optics." Appeal Br. 23 (Claims App'x). Claim 8 recites "[t]he method of claim 7, wherein the adjustable optical characteristic is a refractive index [or a temperature or a Zernike coefficient]." Id. The Examiner finds that Feng teaches that the optical characteristics of the projection optics include refractive index. Ans. 9 (citing Feng 9:58–60).

Appellants argue that the Examiner's citation to Feng does not establish that the refractive indexes of the projection optics are adjustable (Reply Br. 8). This argument is not persuasive. Feng explains that the "projection optics" are adjustable and defines "projection optics" as including refractive optics. Feng 4:58–5:9. Because Appellants' argument does not identify reversible error, we sustain the rejection of claim 8.

Claim 9. Claim 9 recites "[t]he method of claim 7, wherein the adjustable optical characteristic is adjustable by a heater configured to heat

an optical element of the projection optics." Appeal Br. 23 (Claims App'x). The Examiner finds that the light source and radiation system of Feng "generate heat or are a heater." Ans. 9. The Examiner's construction of heater is unreasonably broad. In the context of claim 9 and the Specification, a heater is a device used to control temperature. Spec. ¶ 77. A heater, in this context, is not merely any device that incidentally generates heat. We thus agree with Appellants that the Examiner has not identified a heater of Feng that meets the recitations of claim 9 (Reply Br. 8–9), and we do not sustain the Examiner's rejection of claim 9.

Claims 12 and 15. In the Answer, the Examiner makes findings regarding how the recitations of claims 12 and 15 are taught by Feng. Ans. 19–20 (providing citations to Feng). Appellants do not persuasively dispute the Examiner's findings regarding these recitations. We thus sustain the Examiner's rejection of claims 12 and 15.

DECISION

For the above reasons, we affirm the Examiner's rejection of claims 1, 2, 7, 8, and 10–20. We reverse the Examiner's rejection of claims 3–6 and 9.

No time period for taking any subsequent action in connection with this appeal may be extended under 37 C.F.R. § 1.136(a).

AFFIRMED-IN-PART